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April 26, 1999

BOX PATENT APPLICATION  
Assistant Commissioner for Patents  
Washington, D.C. 20231

Re: Noriyoshi SONETAKA  
RADIO ACCESS SYSTEM WITH  
MEANS FOR DECIDING WHETHER FINAL  
DIGIT OF TELEPHONE NUMBER HAS BEEN PUSHED OR NOT  
Our Ref. Q54131

Dear Sir:

Attached hereto is the application identified above including 15 sheets of the specification, claims, 4 sheets of drawings, executed Assignment and PTO 1595 form, and executed Declaration and Power of Attorney.

The Government filing fee is calculated as follows:

Total claims	6	-	20	=		x	\$18.00	=	\$0.00
Independent claims	1	-	3	=		x	\$78.00	=	\$0.00
Base Fee									\$760.00
<b>TOTAL FILING FEE</b>									<b>\$760.00</b>
Recordation of Assignment									\$40.00
<b>TOTAL FEE</b>									<b>\$800.00</b>

Checks for the statutory filing fee of \$760.00 and Assignment recordation fee of \$40.00 are attached. You are also directed and authorized to charge or credit any difference or overpayment to Deposit Account No. 19-4880. The Commissioner is hereby authorized to charge any fees under 37 C.F.R. §§ 1.16 and 1.17 and any petitions for extension of time under 37 C.F.R. § 1.136 which may be required during the entire pendency of the application to Deposit Account No. 19-4880. A duplicate copy of this transmittal letter is attached.

Priority is claimed from April 28, 1998 based on Japanese Application No. 119485/1998. The priority document is enclosed herewith.

Respectfully submitted,  
SUGHRUE, MION, ZINN,  
MACPEAK & SEAS, PLLC  
Attorneys for Applicant

By: J. Frank Osha  
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Registration No. 24, 625

RADIO ACCESS SYSTEM WITH MEANS FOR DECIDING WHETHER  
FINAL DIGIT OF TELEPHONE NUMBER HAS BEEN PUSHED OR NOT

BACKGROUND OF THE INVENTION

5 1. Field of the Invention:

The present invention relates to a radio access system having a subscriber terminal, a base station connectable to the subscriber terminal via a radio link, a base station control station for controlling the base station, and an exchange accommodating a telephone set and connected to the base station control station.

2. Description of the Related Art:

Heretofore, telephone systems based on radio communications, such as portable telephone systems, transmit off-hook and dialing signals according to a predetermined signal sequence to base stations.

One such telephone system is disclosed in Japanese laid-open patent publication No. 63-78643.

An operation sequence of the disclosed telephone system will be described below with reference to Fig. 1 of the accompanying drawings. As shown in Fig. 1, when the handset of a telephone set 5 is removed from its switch (off-hook state), a subscriber terminal 4 transmits a false dial tone (DT) to the telephone set 5. At the same time, the subscriber terminal 4 operates on a base station 3 or a base station control station 2 to es-

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establish a radio link between the subscriber terminal 4 and the base station 3 (or the base station control station 2). The subscriber terminal 4 also decides whether keys of the dial or push-button pad on the telephone set are pushed to dial a telephone number and whether a dialing signal from the telephone set 5 represents a final digit of the dialed telephone number. If the radio link has been established and the dialing signal represents the final digit, the subscriber terminal 4 sends dialing information to the base station 3 (or the base station control station 2). The disclosed telephone system is silent as to a specific process for determining the final digit. The base station 3 (or the base station control station 2) converts the received dialing information to a dialing signal (PB or DP), which is supplied to an exchange 1 that operates to call the destination party.

Portable telephone systems employ an inter-digit timer for measuring an inter-digit pause. A final digit of the dialed telephone number is determined when no dialing signal comes in as detected by the inter-digit timer.

In the telephone system disclosed in Japanese laid-open patent publication No. 63-78643, the subscriber terminal has a circuit for deciding whether a dialing signal from the telephone set represents a final digit of the dialed telephone number, and a means for transmitting di-

aling signals altogether which have been generated when keys of the dial pad are pushed.

However, the conventional telephone system suffers the following problems:

5           1) A long period of time is required after the subscriber has pushed keys of the dial pad until a final digit of the dialed telephone number is determined.

          2) A long period of time is required after the final digit has been determined until the subscriber is able to  
10 talk to the called party.

          3) If the inter-digit timer is set to too a short period of time, then the dialing information is transmitted to the base station while the subscriber is dialing the telephone number, tending to result in a connection  
15 failure or error.

          4) If the inter-digit timer is set to too a long period of time, then a connection failure or error is also liable to occur.

## 20                               SUMMARY OF THE INVENTION

It is an object of the present invention to provide a radio access system which can solve the problem of a delay caused by the outbound transmission of dialing signals, which is inherent in a portable telephone system.

25           A radio access system according to the present invention has a subscriber terminal, a base station con-

nectable to the subscriber terminal via a radio link, a  
base station control station for controlling the base  
station, and an exchange accommodating a telephone set  
and connected to the base station control station. The  
5 subscriber terminal detects when the telephone set is in  
an off-hook state, sends a dial tone to the telephone  
set, establishes a radio link between the subscriber ter-  
minal and the base station or the base station control  
station, thereafter receives dialing signals, which are  
10 generated when keys of a dial pad on the telephone set  
are pushed to dial a telephone number, sent from the  
telephone set to the base station or the base station  
control station. Either the base station or the sub-  
scriber terminal has a means for deciding whether a dial-  
15 ing signal represents a final digit of the dialed tele-  
phone number or not.

Since either the base station or the subscriber ter-  
minal has a means for deciding whether a dialing signal  
represents a final digit of the dialed telephone number  
20 or not, the radio access system is capable of solving the  
problem of a delay caused by the outbound transmission of  
dialing signals, which is inherent in a portable tele-  
phone system.

The radio access system can provide radio service  
25 between the base station and the subscriber's home, and  
hence is advantageous from the standpoint of subscriber

equipment installation, maintenance, and early operational capability.

The above means may comprise an inter-digit timer and means for determining that a dialing signal represents a final digit of the dialed telephone number if a  
5 key of the dial pad has not been pushed for a predetermined period of time.

The above means may also comprise means for counting dialing signals sent from the telephone set.

10 The above and other objects, features, and advantages of the present invention will become apparent from the following description when taken in conjunction with the accompanying drawings which illustrate some preferred embodiments of the present invention by way of example.

15 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram showing an operation sequence of a conventional telephone system;

Fig. 2 is a block diagram of a radio access system according to the present invention;

20 Fig. 3 is a diagram showing an operation sequence of the radio access system shown in Fig. 2; and

Fig. 4 is a diagram showing another operation sequence of the radio access system shown in Fig. 2.

25 DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the Fig. 2, there is shown a radio

access system according to the present invention which comprises an exchange 1, a base station control station 2, a plurality of base stations 3, a plurality of subscriber terminals 4, and a plurality of telephone sets 5.

5           The base stations 3 are connected to the base station control station 2 by cables 202 including optical fibers. Each of the base stations 3 which are connected to the base station control station 2 by radio signals comprises antennas 301, 302, a sending and receiving circuit 310 for receiving radio signals from the base station control station 2 and sending radio signals to the base station control station 2, a converting circuit 313 for converting signals to radio signals for transmission to the subscriber terminals 4, and a converting circuit 10 311 for converting signals from the base station control station 2 and the subscriber terminals 4 to radio signals. The base station control station 2 has an antenna 201 for sending and receiving radio signals. Each of the base stations 3 which are connected to the base station control station 2 by the cables 202 has the antenna 302, the converting circuit 313, and a converting circuit 312, which is similar to the converting circuit 311, for converting signals to radio signals.

Each of the subscriber terminals 4 comprises an antenna 401 for sending radio signals to the base stations 3 and receiving radio signals from the base stations 3, a 25

converting circuit 410 for converting signals to radio signals, and a telephone set interface converting circuit 411 for receiving radio signals. The telephone set interface converting circuit 411 can be connected to one of the telephone sets 5. The subscriber terminals 4 include a telephone set interface converting circuit 412, similar to the telephone set interface converting circuit 411, which can accommodate a plurality of telephone sets 5.

Operation of the radio access system shown in Fig. 2 will be described below with reference to Fig. 3.

When a subscriber removes the handset of the telephone set 5 from its switch (off-hook state), the corresponding subscriber terminal 4 detects the off-hook state, and sends a false dial tone (DT) to the telephone set 5. At the same time, the subscriber terminal 4 operates on a base station 3 or a base station control station 2 to establish a radio link between the subscriber terminal 4 and the base station 3 (or the base station control station 2). The subscriber terminal 4 then sends a dialing signal (PB or PD), produced each time a key of the dial pad on the telephone set 5 is pushed to dial a telephone number, to the base station 3 (or the base station control station 2). The base station 3 decides whether a dialing signal represents a final digit of the dialed telephone number or not. If a dialing signal represents a final digit of the dialed telephone number,



then the base station 3 opens an inbound communication link. The dialing signals are transmitted as outbound signals.

The base station 3 decides whether a dialing signal  
5 represents a final digit of the dialed telephone number by either:

1) using an inter-digit timer 500 (see Fig. 2) connected to the base station 3 and determining a final  
10 digit of the dialed telephone number if a key of the dial pad has not been pushed for a predetermined period of time, as measured by the inter-digit timer 500; or

2) counting digits of the dialed telephone number.

When the subscriber places the handset of the telephone set 5 on its switch (on-hook state), the subscriber  
15 terminal 4 detects the on-hook state, and breaks the radio link between the base station 3 (or the base station control station 2) and the subscriber terminal 4.

Fig. 4 shows another operation sequence of the radio access system shown in Fig. 2. According to the operation sequence shown in Fig. 4, the telephone terminal 5  
20 sends a dialing signal representing a first digit of the dialed telephone number to the subscriber terminal 4 before the acknowledgment of a connection is sent from the base station control station 2 to the subscriber terminal  
25 4.

The radio access system shown in Fig. 2 may be modi-

fied as follows:

1) The exchange 1 and the base station control station 2 may be connected by radio links or cables.

2) The exchange 1 may be connected directly to ordinary telephone sets 5 on a ground network or may be connected to a private branch exchange (PBX) on a ground network which is equivalent to the exchange 1.

3) The base station control station 2 and the base station 3 may be connected to each other by radio links, optical fibers, metal cables, or any other mediums capable of transmitting signals for communications.

4) The base station control station 2 and the base station 3 may be connected to each other in a point-to-point or point-to-multipoint access configuration.

5) The base station 3 and the subscriber terminals 4 are connected to each other by radio links. On the basis of a point-to-multipoint (or point-to-point) multiplex system, signals to be transmitted between the base station 3 and the subscriber terminals 4 may be multiplexed by TDMA (Time-Division Multiple Access), FDMA (Frequency-Division Multiplex Access), CDMA (Code-Division Multiplex Access), or the like.

6) A radio access system between the base station 3 and the subscriber terminals 4 may be GSM (Global System for Mobile Communication), AMPS (Advanced Mobile Phone Service), PDC (Personal Digital Cellular), PCS (Personal

Communication System), DECT (Digital European Cordless Telephone), PHS (Personal Handyphone System), or the like.

7) One or more subscriber terminals 4 and one or more telephone sets 4 may be connected.

The operation sequences shown in Figs. 4 and 4 may be modified as follows:

1) When the handset of a telephone set 5 is removed from its switch and keys of the dial pad are pushed while the base station 3 (or the base station control station 2) and the subscriber terminal 4 are performing a control process to establish a link, the subscriber terminal 4 may temporarily store a set of dialing signals, and then send the stored dialing signals after the link has been established (see Fig. 4).

2) The base station 3 which has received a dialing signal has a function to convert the dialing signal to a PB or PD dialing signal. This converting function may be performed by the base station control station 2.

3) The value of the inter-digit timer 500 connected to the base station 3 (or the base station control station 2) may be made variable.

4) The number of digits counted by the base station 3 (or the base station control station 2) may be made variable. Specifically, the number of digits is "10" if a dialed telephone number is "03-1234-1567", for example,

and the inter-digit timer is actuated when the number of digits reaches "10" at the time the key "7" of the dial pad is pushed. If a dialed telephone number is an overseas telephone number of "001-81-3-1234-1567", for example, then the inter-digit timer is actuated when the number of digits reaches "14" at the time the key "7" of the dial pad is pushed. The number of digits is counted in a different manner from carrier to carrier, and may be counted to suit individual applications.

5) The inter-digit timer and the function to count the number of digit may be provided in each of the subscriber terminals 4.

6) There may be employed a means for sending a busy tone (BT) or a means for sending an arbitrary tone such as a howler tone (HWT) with an arbitrary setting unless a key of the dial pad is pushed for a certain period of time (which may be arbitrarily set) after a dial tone has been sent from the subscriber terminal 4.

Although certain preferred embodiments of the present invention have been shown and described in detail, it should be understood that various changes and modifications may be made therein without departing from the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A radio access system comprising:

a subscriber terminal;

a base station connectable to said subscriber terminal via a radio link;

5 a base station control station for controlling said base station; and

an exchange accommodating a telephone set and connected to said base station control station;

the arrangement being such that said subscriber terminal detects when the telephone set is in an off-hook state, sends a dial tone to the telephone set, establishes a radio link between said subscriber terminal and said base station or said base station control station, thereafter receives dialing signals, which are generated  
10 when keys of a dial pad on the telephone set are pushed to dial a telephone number, sent from said telephone set to said base station or said base station control station;

either said base station or said subscriber terminal  
20 having means for deciding whether a dialing signal represents a final digit of the dialed telephone number or not.

2. A radio access system according to claim 1,

wherein said means comprises an inter-digit timer and means for determining that a dialing signal represents a final digit of the dialed telephone number if a key of  
5 the dial pad has not been pushed for a predetermined period of time.

3. A radio access system according to claim 1, wherein said means comprises means for counting dialing signals sent from said telephone set.

4. A radio access system according to claim 1, wherein said base station comprises means for opening an inbound communication link between the base station and said subscriber terminal if a dialing signal represents a  
5 final digit of the dialed telephone number.

5. A radio access system according to claim 2, wherein said base station comprises means for opening an inbound communication link between the base station and said subscriber terminal if a dialing signal represents a  
5 final digit of the dialed telephone number.

6. A radio access system according to claim 3, wherein said base station comprises means for opening an inbound communication link between the base station and said subscriber terminal if a dialing signal represents a

5 final digit of the dialed telephone number.

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# ABSTRACT OF THE DISCLOSURE

5 A radio access system has a subscriber terminal, a  
base station connectable to the subscriber terminal via a  
radio link, a base station control station for control-  
ling the base station, and an exchange accommodating a  
telephone set and connected to the base station control  
station. When the subscriber removes the handset of the  
telephone set from its switch, the subscriber terminal  
sends a false dial tone to the telephone set, and estab-  
lishes a radio link between the subscriber terminal and  
the base station or the base station control station.  
The subscriber terminal receives dialing signals (PB or  
PD dialing signals), which are generated when keys of a  
dial pad on the telephone set are pushed to dial a tele-  
phone number, and sends the dialing signals to the base  
station or the base station control station. The base  
station decides whether a dialing signal represents a fi-  
nal digit of the dialed telephone number or not. If a  
dialing signal represents a final digit of the dialed  
telephone number, then the base station opens a communi-  
cation link.



Fig. 1 (Prior Art)

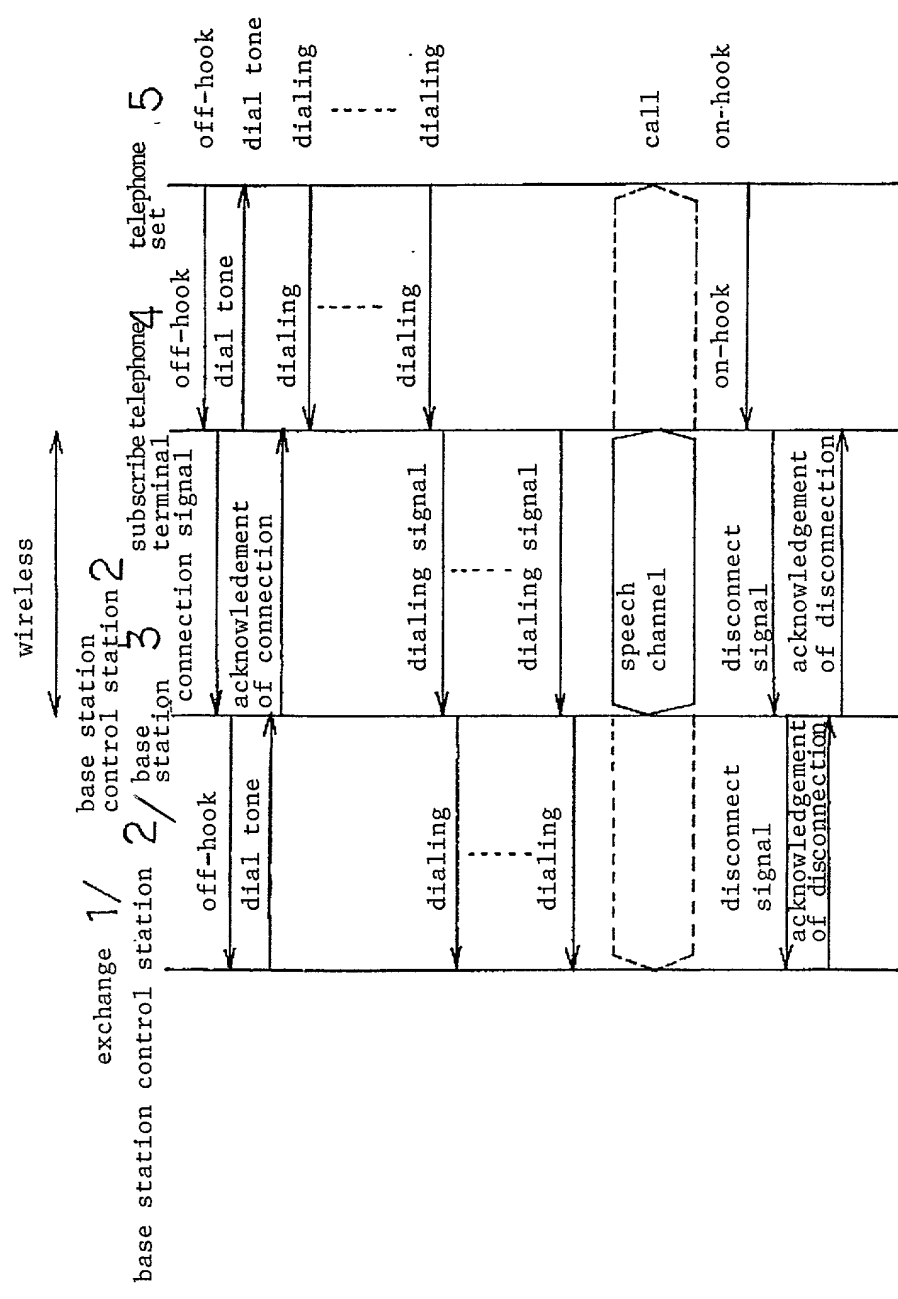


Fig. 2

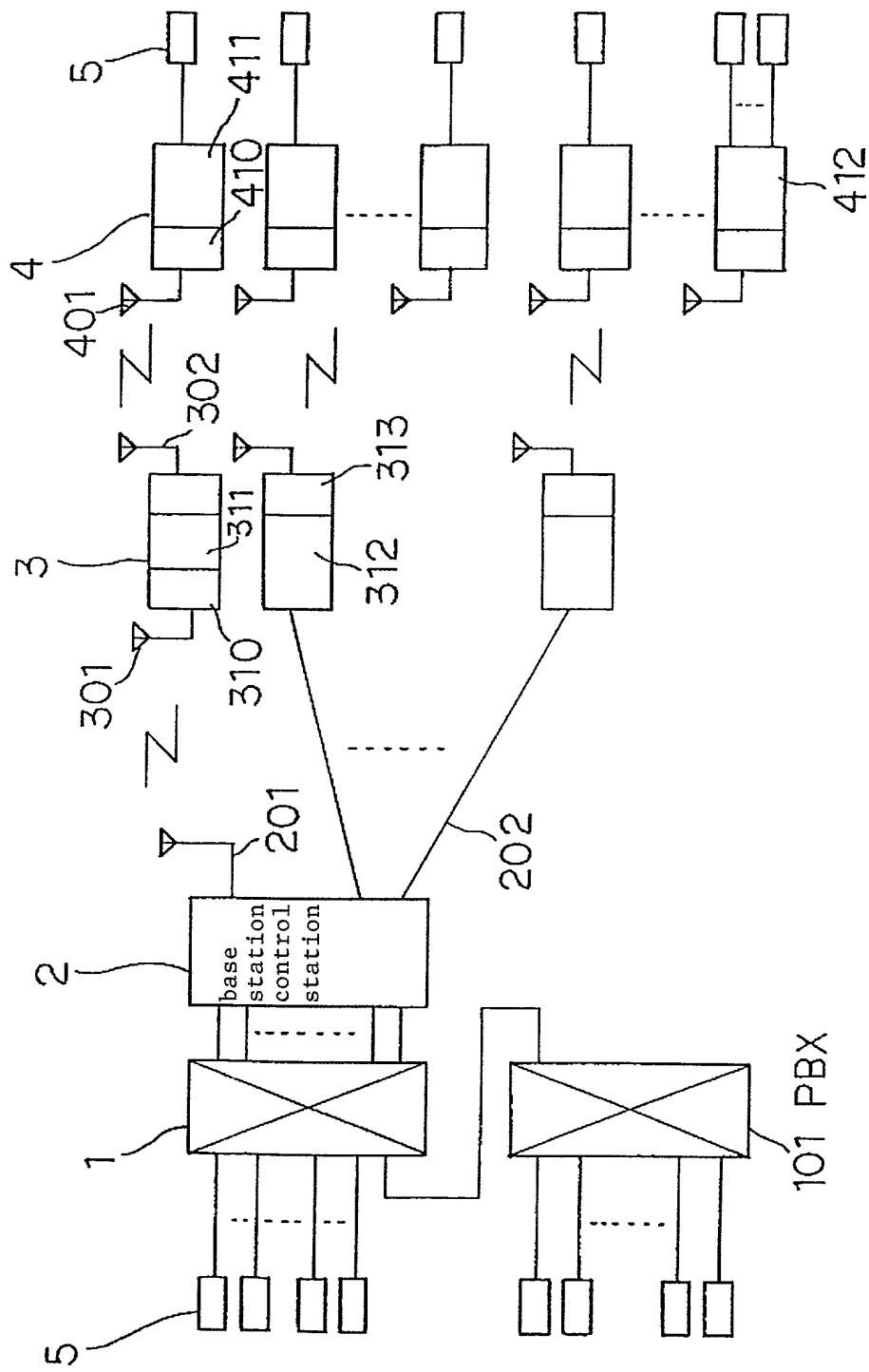
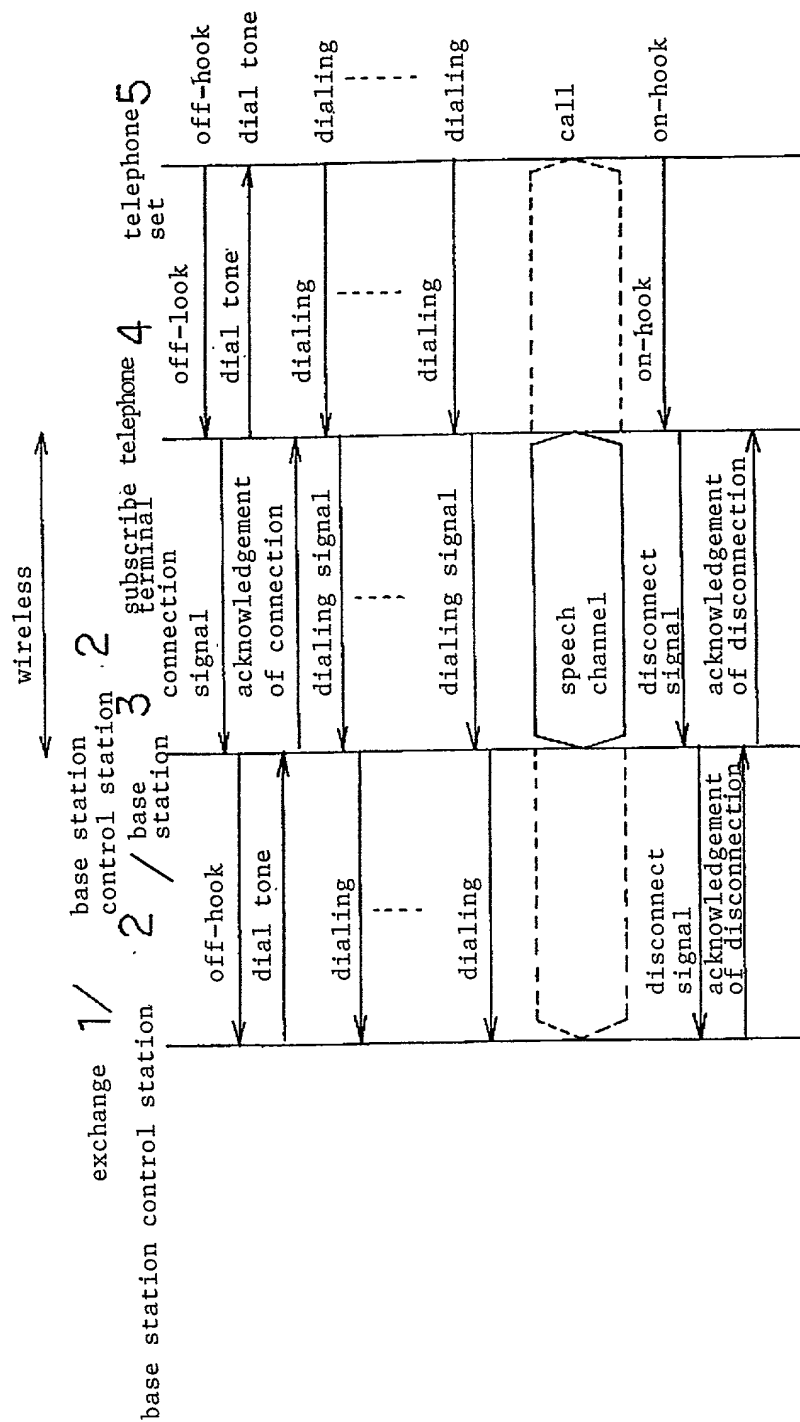


Fig. 3





**DECLARATION AND POWER OF ATTORNEY**

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name: that I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural names are listed below) of the subject matter claimed and for which a patent is sought in the application entitled:

**RADIO ACCESS SYSTEM WITH MEANS FOR DECIDING WHETHER FINAL DIGIT OF TELEPHONE NUMBER**

**HAS BEEN PUSHED OR NOT**

which application is:

☒ the attached application  
(for original application)

\_\_\_\_\_ application Serial No. \_\_\_\_\_  
filed \_\_\_\_\_, and amended on \_\_\_\_\_

\_\_\_\_\_  
(for declaration not accompanying application)

that I have reviewed and understand the contents of the specification of the above-identified application, including the claims, as amended by any amendment referred to above; that I acknowledge my duty to disclose information of which I am aware which is material to the patentability of this application under 37 C.F.R. 1.56, that I hereby claim foreign priority benefits under Title 35, United States Code §119, §172 or §365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified on said list any foreign application for patent or inventor's certificate on this invention having a filing date before that of the application on which priority is claimed:

Application Number	Country	Filing Date	Priority Claimed (yes or no)
119485/1998	Japan	April 28, 1998	Yes

I hereby claim the benefit of Title 35, United States Code §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in a listed prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge my duty to disclose any information material to the patentability of this application under 37 C.F.R. 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.	Filing Date	Status (patented, pending, abandoned)

I hereby appoint John H. Mion, Reg. No. 18,879; Donald E. Zinn, Reg. No. 19,046; Thomas J. Macpeak, Reg. No. 19,292; Robert J. Seas, Jr., Reg. No. 21,092; Darryl Mexic, Reg. No. 23,063; Robert V. Sloan, Reg. No. 22,775; Peter D. Olexy, Reg. No. 24,513; J. Frank Osha, Reg. No. 24,625; Waddell A. Biggart, Reg. No. 24,861; Robert G. McMorrow, Reg. No. 19,093; Louis Gubinsky, Reg. No. 24,835; Neil B. Siegel, Reg. No. 25,200; David J. Cushing, Reg. No. 28,703; John R. Inge, Reg. No. 26,916; Joseph J. Ruch, Jr., Reg. No. 26,577; Sheldon I. Landsman, Reg. No. 25,430; Richard C. Turner, Reg. No. 29,710; Howard L. Bernstein, Reg. No. 25,665; Alan J. Kasper, Reg. No. 25,426; Kenneth J. Burchfiel, Reg. No. 31,333; Gordon Kit, Reg. No. 30,764; Susan J. Mack, Reg. No. 30,951; Frank L. Bernstein, Reg. No. 31,484; Mark Boland, Reg. No. 32,197; William H. Mandir, Reg. No. 32,156; Scott M. Daniels, Reg. No. 32,562; Brian W. Hannon, Reg. No. 32,778 and Abraham J. Rosner, Reg. No. 33,276, my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and request that all correspondence about the application be addressed to **SUGHRUE, MION, ZINN, MACPEAK & SEAS**, 2100 Pennsylvania Avenue, N.W., Washington, D.C. 20037-3202.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date April 16, 1999

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